Draft for Comment

U.S. NUCLEAR REGULATORY COMMISSION

DESIGN SPECIFIC REVIEW STANDARD FOR NuScale SMR DESIGN

14.2 INITIAL PLANT TEST PROGRAM - DESIGN CERTIFICATION AND NEW LICENSE APPLICANTS

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of Quality Assurance (QA) and Initial Test Programs (ITPs).

Secondary - Relevant technical organizations responsible for a portion of the review of the ITP with subject matter expertise on the design and test acceptance criteria of specifically assigned structures, systems and components (SSCs).

I. AREAS OF REVIEW

The U.S. Nuclear Regulatory Commission (NRC) staff reviews and evaluates the ITP submitted by design certification (DC) and combined license (COL) applicants. Although there is no regulatory requirement for a DC applicant to provide an ITP, in practice, DC applicants have provided test abstracts for their design that can be used by a COL applicant referencing their DC to develop an ITP.

The staff reviews the NuScale ITP for DC in accordance with the requirements of 10 CFR 52.79 (a)(28) and Appendix A, "General Design Criteria," and Criterion XI, "Test Control," of Appendix B, "Quality Assurance," to 10 CFR Part 50. The staff will determine if the DC and COL applicant adequately addressed the methods and guidance in RG 1.68, Revision 4 and other RGs referenced in Design Specific Review Standard (DSRS) 14.2 for NuScale and RG 1.68, Revision 4, in developing the ITP for the NuScale light-water small module reactor (SMR).

The primary review branch verifies that the DC and COL applicant describes test methods acceptable to the NRC staff to meet QA and ITP guidance in Regulatory Guide (RG) 1.68. The secondary review branches review the specific design and test acceptance criteria assigned to each SSC to verify that these criteria are adequate to ensure that each SSC will meet its design basis.

The specific areas of review are as follows:

1. The ITP addresses the applicant's plan for preoperational and initial startup testing. The test program consists of preoperational and initial startup tests, as described in RG 1.68. Preoperational tests consist of those tests conducted following completion of construction and construction-related inspections and tests, but before fuel loading. Such tests demonstrate, to the extent practicable, the capability of SSCs to meet

ADAMS Accession No. ML15084A407

performance requirements and design criteria. Initial startup tests include those test activities scheduled to be performed during and following fuel activities. Testing activities include fuel loading, precritical tests, initial criticality, low-power tests, and power ascension tests that confirm the design bases and demonstrate, to the extent practicable, that the plant will operate in accordance with its design and is capable of responding as designed to anticipated transients and postulated accidents.

2. COL Action Items and Certification Requirements and Restrictions.

   For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

   For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC.

Review Interfaces

Other design specific review standard (DSRS) sections interface with this section as follows:

1. For COL and OL applicants, the QA staff reviews the information provided by the applicant to ensure that the overall ITP is acceptable. The relevant technical reviewers ensure, for their particular areas of review, that specific test objectives, test methods, and acceptance criteria are acceptable and consistent with the design requirements for the facility in accordance with the technical reviewers' guidance. The QA staff also evaluates the nuclear steam supply system (NSSS) vendor involvement in the development of the plant ITP, including NSSS vendor review of test procedures.

2. For DC reviews, even though there is no requirement for a DC applicant to provide an ITP, the staff should review the test abstracts provided by the DC applicant for completeness and suitability for development of an ITP by a COL applicant. For consistency between ITP and ITAAC regulations, the NRC staff also reviews the preoperational test acceptance criteria under the ITP to verify that they are consistent with the acceptance criteria under the preoperational test ITAAC.

   For example, the relevant technical reviewers responsible for reviewing the design of a specific system and/or design feature will assess certain tests, such as (1) those for the reactor systems, containment systems, electrical power systems, emergency core cooling systems, security systems, and related features or (2) those identified for design-specific or unique (for example, first-of-a-kind (FOAK)) plant features). For those areas of review identified above, additional acceptance criteria and/or review methods beyond those described in this section are specified in other RGs (for example, RG 1.20). These acceptance criteria and/or review methods are also of use in the overall evaluation of issues related to the ITP, such as (1) the adequacy of testing proposed for specific SSCs and/or design features and (2) the design parameters, characteristics, and performance criteria that should be satisfactorily demonstrated by testing.

This DSRS is organized into six areas of review. Section II discusses these areas of review in detail.

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. Title 10 of the *Code of Federal Regulations* (CFR), Section 50.2, *Prototype plant* means a nuclear reactor that is used to test design features, such as the testing required under § 50.43(e). The prototype plant is similar to FOAK or standard plant design in all features and size, but may include additional safety features to protect the public and the plant staff from the possible consequences of accidents during the testing period.

2. 10 CFR 52.47(a)(2) requires a DC application to include a description and analysis of the SSCs of the facility with an emphasis upon performance requirements, the bases, and technical justification for these requirements. In addition, 10 CFR 52.47(a)(2)(iii) specifies that the NRC will take into consideration the extent to which the reactor incorporates unique, unusual or enhanced safety features having a significant bearing on the probability for accidental release of radioactive material. 10 CFR 52.79(a)(2)(iii) requires the COL applicant's FSAR and the NRC to take into consideration the extent to which the reactor incorporates unique, unusual or enhanced safety features having a significant bearing on the probability for accidental release of radioactive material.

3. Based on the requirements in 10 CFR 52.47(a)(2)(iii) and 10 CFR 52.79(a)(28), the COL applicant should also provide plans for preoperational testing and tests for initial operations. This includes plans for testing unique, unusual, FOAK design features or enhanced safety features. This also applies to a COL applicant referencing a DC under 10 CFR Part 52. The DC applicant would provide design and test acceptance critera for preoperational, low power and power ascension tests that are unique, unusual, FOAK design features or enhanced safety features and the COL would implement the ITP to confirm that FOAK design features must meet their design and test acceptance criteria.

4. 10 CFR 50.43(e) requires applications for DC, COL, or manufacturing license (ML) that propose nuclear reactor designs which differ significantly from light-water reactor designs that were licensed before 1997, or use simplified, inherent, passive or other innovative means to accomplish their safety functions, will be approved only if, through either analysis, appropriate test programs, experience or a combination thereof, the performance of each safety feature of the design are demonstrated and the interdependent effects among the safety features of the design are acceptable. In addition, sufficient data on the safety features of the design must exist to asses the analytical tools used for the safety analysis over a sufficient range of normal operating conditions, transient conditions, and specified accident sequences, including equilibrium core conditions. In the alternative, such applications may be approved if there has been acceptable testing of a prototype plant over a sufficient range of normal operating conditions, transient conditions, and specified accident sequences, including equilibrium core conditions. If a prototype plant is used to comply with the testing requirements, then the NRC may impose additional requirements on siting, safety features, or operational conditions for the prototype plant to protect the public and the plant saff from the possible consequences of accidents during the testing period. This also applies to a COL applicant referencing a DC under 10 CFR Part 52. The DC applicant would provide

test acceptance criteria to provide objective evidence that the prototype plant or FOAK tests will meet their design basis and the COL would implement the ITP to confirm that FOAK tests meet their design basis.

5. 10 CFR 52.47(c)(2) requires that an application for certification of a nuclear power reactor design that differs significantly from the light-water reactor designs described in paragraph (c)(1) of this section or uses simplified, inherent, passive, or other innovative means to accomplish its safety functions must provide an essentially complete nuclear power reactor design except for site-specific elements such as the service water intake structure and the ultimate heat sink, and must meet the requirements of 10 CFR 50.43(e).

6. The regulations in 10 CFR 50.43(e) also apply to DC and COL applications licensed under 10 CFR 52.47(a)(2)(iii), 10 CFR 52.47(c)(2) and 10 CFR 52.79(a)(28). In practice, the DC applicant would provide design and test acceptance criteria for its portion of the design while the COL applicant would provide design and test acceptance criteria for site-specific design features (e.g., ultimate heat sink). The COL would then implement plans for preoperational, initial criticality, low power and power ascenstion tests under the ITP.

7. 10 CFR 30.53(c), as it relates to testing radiation detection and monitoring instruments.

8. Section XI of Appendix B to 10 CFR Part 50, as it relates to test programs established to assure that SSCs will perform satisfactorily in service.

9. Section III.A.4 of Appendix J to 10 CFR Part 50, as it relates to the preoperational leakage rate testing of the primary reactor containment and related systems and components penetrating the primary containment pressure boundary.

10. 10 CFR 52.79(a)(28) requires COL applicants to provide plans for preoperational testing and initial operations.

DSRS Acceptance Criteria

Specific DSRS acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are set forth below. The DSRS is not a substitute for the NRC's regulations, and compliance with it is not required. As an alternative, and as described in more detail below, an applicant may identify the differences between a DSRS section and the design features (DC and COL applications only), analytical techniques, and procedural measures proposed in an application and discuss how the proposed alternative provides an acceptable method of complying with the NRC regulations that underlie the DSRS acceptance criteria.

1. Summary of Test Program and Objectives

   This DSRS section lists the general criteria of RG 1.68 that a DC and COL applicant or holder should address in its FSAR.

DC/COL/OL Applicants

A. The ITP should describe its objectives, including a description of the objectives for each of the major phases of the test program.

B. The ITP should describe the criteria for selection of plant features to be tested by the applicant.

C. Objectives and testing selection criteria should be consistent with the general guidelines and applicable regulatory positions in RG 1.68. Applicants should appropriately justify exceptions.

2. Test Program's Conformance with Regulatory Guides

DC/COL Applicants

A. The applicant should commit to the revision of RG 1.68 and the RGs listed in RG 1.68, that are referenced in this DSRS and are in effect six months prior to the docket date of the application. The applicant may propose exceptions or alternatives to the specific criteria in any of these RGs, and the staff may find them acceptable if the applicant provides adequate justification to meet the intent of 10 CFR 52.47(a)(9), "Contents of applications; technical information." The application must identify and describe all differences between the standard plant design and this DSRS section, and discuss how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria. If the design assumptions in the DC application deviate significantly from the DSRS, the staff will use the Standard Review Plan (SRP) as specified in 10 CFR 52.47 (a)(9). Alternatively, the staff may revise the DSRS section in order to address new design assumptions. The same approach may be used to meet the requirements of 10 CFR 52.79(a)(41) for COL applications, respectively.

B. The reviewer responsible for the RG evaluates any exceptions or alternatives. The safety evaluation report (SER) should also list such exceptions or alternatives.

3. ITP Administrative Procedures

DC Applicant

The applicant should provide a summary description of the following areas:

A. The applicant should provide general guidance to control ITP activities, including administrative controls that will be used to develop, review, and approve individual test procedures, coordination with organizations involved in the test program, participation of plant operating and technical staff, and review, evaluation, and approval of test results.

B. The applicant should include general guidance for the review of relevant operating and testing experiences at other facilities. This guidance should recognize reportable occurrences of repeatedly experienced safety concerns and

other operating experiences that could potentially impact the performance of the test program.

C. The applicant should include general guidance about how, and to what extent, the test program will use and/or test plant operating, emergency, and surveillance procedures.

D. The applicant should provide test abstracts of SSCs and unique design features that will be tested to verify that system and component performance is in accordance with the design. These test abstracts should include the objectives, tests, and acceptance criteria that will be included in the test procedures.

COL Applicant

The applicant should provide a detailed description of the following areas:

A. Management Organizations

i. The applicant should provide organizational descriptions for principal management positions responsible for the planning, execution, and documentation of preoperational and startup testing activities.

ii. The applicant should provide (1) the organizational descriptions for any augmenting organizations or other personnel who will manage or execute any phase of the test program, and (2) the responsibilities, interfaces, and authorities of the principal participants.

B. Conduct of the ITP

i. The applicant should conduct the ITP using detailed procedures approved by designated managers in the applicant's organization.

ii. Administrative controls should be established to ensure that the designated construction-related inspections and tests are completed before preoperational testing begins. The applicant should also include in the ITP adequate controls for the evaluation and approval of preoperational test results before initial startup tests begin.

iii. Administrative controls should address adherence to approved test procedures during the conduct of the test program and the methods for effecting changes to approved test procedures.

iv. The controls that the applicant uses to ensure that the test prerequisites are met should include requirements for (1) inspections, checks, and similar controls, (2) identification of test personnel completing data forms or checksheets, and (3) identification of dates of completion. Each major phase of the test program as well as individual tests should satisfy these requirements.

v. The staff will find that the controls provided for plant modification and repairs, identified as a result of plant testing, are acceptable if the controls (1) are sufficient to ensure that the required repairs or modifications will

be made, (2) will ensure retesting is conducted following such modifications or repairs, and (3) will ensure a review of any proposed facility modifications by the original design organization or other designated design organizations. The applicant's requirements for documentation associated with such controls should permit audits to be conducted to ensure its proper implementation.

C. Test Program Schedule and Sequence

i. The applicant should develop a schedule for conducting each major phase of the ITP.

ii. The schedule should establish that the safety of the plant will not depend on the performance of untested SSCs.

iii. Overlapping test program schedules (for multiunit sites) should not result in significant divisions of responsibilities or dilutions of the staff implementing the test program.

iv. The sequential schedule for individual startup tests should establish that test requirements will be completed in accordance with plant technical specification requirements for SSC operability before changing plant modes.

D. Staff Responsibilities, Authorities, and Qualifications

i. The applicant should describe the education, training, and experience requirements established for each management and operating staff member including the NSSS vendor, architect-engineer, and other major contractors, subcontractors, and vendors, as appropriate, who will conduct the preoperational and startup tests and will develop testing, operating, and emergency procedures.

ii. The applicant should develop a training program for each functional group of employees in the organization relative to the schedule for preoperational testing and initial startup testing to ensure that the necessary plant staff are ready to begin the test program.

E. Development, Review, and Approval of Test Procedures

i. The applicant is responsible for the preparation of preoperational and startup test procedures. This includes the methodology used for the generation, review, and approval of test procedures.

ii. The applicant should use the NSSS vendor, architect-engineer, and other major contractors, as appropriate, to provide the test objectives and acceptance criteria used in developing detailed test procedures.

iii. The applicant's administrative system for use in reviewing and approving individual test procedures should provide for appropriate levels of review before approval.

iv. Controls should be in place to ensure that test procedures include appropriate prerequisites, test objectives, safety precautions, testing of initial conditions, methods to direct and control test performance, and acceptance criteria for evaluating the test.

v. The applicant should include provisions to ensure that retesting that is required for modifications or maintenance remains in compliance with ITAAC commitments.

vi. The format for the test procedures should be similar to that in RG 1.68, or the reviewer should consider whether the justification provided by the applicant for exception is acceptable. The format should include checklists and signature blocks to control the sequencing of testing.

vii. Approved test procedures should be in a form suitable for review by regulatory inspectors at least 60 days before their intended use. Licensees should provide timely notification to NRC of changes in approved test procedures that have been made available for NRC review.

F. Review, Evaluation, and Approval of Test Results

i. The applicant should develop the procedures that will govern the review, evaluation, and approval of test results for each phase of the test program. Specific procedures should be implemented to ensure notification of responsible organizations, such as design organizations, when test acceptance criteria are not met and specific controls have been established to resolve such problems.

ii. Before proceeding with testing, the applicant should provide controls relating to (1) the methods and schedules for approval of test data for each major phase, and (2) the methods used for initial review of individual parts of multiple tests (e.g., hot functional testing).

iii. The controls that will govern the review, evaluation, and approval of test results should provide a technical evaluation of test results by qualified personnel and approval of such results by personnel in designated management positions in the applicant's organization.

iv. The applicant should include provisions to allow design organizations to participate in the resolution of design-related problems that result in, or contribute to, a failure to meet test acceptance criteria.

v. Provisions should be in place to retain test reports, including test procedures and results, as part of the plant historical records. Startup test reports should be prepared in accordance with RG 1.16, or the reviewer should consider whether the justification provided by the applicant for exception is acceptable.

G. Utilization of Reactor Operating and Testing Experiences in the Development of the Test Program

i. The applicant should provide a summary of the principal conclusions or findings from the review of operating and testing experiences at other reactor facilities and their effect on the test program. This review should recognize categories of reportable, repeatedly experienced occurrences and other operating experiences that could potentially impact the performance of the test program.

H. Trial Use of Plant Operating and Emergency Procedures

i. The applicant should incorporate, to the extent practicable, the plant operating, emergency, and surveillance procedures into the test program or otherwise verify these procedures through use during the test program.

ii. The applicant should provide additional operator training and participation based on the performance and evaluation of the test results of certain initial tests. An acceptable program will satisfy the criteria described in Three Mile Island (TMI) Action Plan Item I.G.1 of NUREG-0660 and NUREG-0737.

4. Initial Startup Tests

DC Applicant

The applicant should provide a summary description of the following areas:

A. Initial Fuel Loading/Initial Criticality/Low-Power/Power Ascension Testing

i. The applicant should include in the ITP a description of the general provisions and precautions for fuel loading, initial fuel loading, initial criticality, low-power testing, and power ascension phases. Precautions, prerequisites, and measures should be consistent with the guidelines and regulatory positions in RG 1.68. This includes guidance for (1) the completion of all ITAAC associated with preoperational tests before fuel load, (2) measures to review and evaluate the results of the completed preoperational tests, (3) appropriate remedial actions to take if acceptance criteria are not satisfied, (4) applicable technical specification requirements, and (5) actions to take if unanticipated errors or malfunctions occur.

COL Applicants

The applicant should provide a detailed description of the following areas:

A. Initial Fuel Loading and Initial Criticality

i. The applicant should provide measures to ensure that preoperational tests are evaluated and approved before fuel loading begins.

ii. The procedures that will guide initial fuel loading and initial criticality should include precautions, prerequisites, and measures consistent with the guidelines and regulatory positions in RG 1.68. The staff will review

exceptions to regulatory positions and their associated justification on a case-by-case basis.

iii. Technical specifications should be instituted to ensure the operability of systems required for fuel loading.

iv. The applicant should describe the minimum conditions for initial core loading, which may include, but are not limited to:

(1) The reactor containment structure should be complete, and containment integrity should be demonstrated according to technical specifications.

(2) Fuel handling tools and equipment should be available, and operators should be familiar with the use and operation of equipment.

(3) The reactor vessel and associated components should be ready to receive fuel.

(4) Nuclear instrumentation should be tested and verified to be operable.

v. The applicant should include provisions to verify that core flux levels are within predicted or acceptable values.

vi. The applicant should provide measures to stop core loading operations if an unexpected or unanalyzed condition occurs.

vii. At the completion of fuel loading, the applicant should perform sufficient tests, as necessary, to ensure that the facility is in a final state of readiness to achieve initial criticality and to perform low-power tests.

B. Low-Power/Power Ascension Testing

i. The applicant should include procedures that will control low-power and power ascension testing. These procedures should include precautions, prerequisites, and measures consistent with the guidelines and regulatory positions in RG 1.68. The staff will review exceptions to regulatory positions and their associated justifications for acceptability on a case-by-case basis.

5. Individual Test Descriptions/Abstracts

DC/COL Applicants

A. The applicant should provide abstracts of planned tests to demonstrate and verify the performance capabilities of SSCs and design features that serve the following functions:

i. Used for safe shutdown and cooldown of the reactor under normal plant conditions and for maintenance of the reactor in a safe condition for an extended shutdown period

ii. Used for safe shutdown and cooldown of the reactor under transient conditions (infrequently or moderately frequent events) and postulated accident conditions and for maintenance of the reactor in a safe condition for an extended shutdown period following such condition

iii. Used for establishing conformance with safety limits or limiting conditions for operation that will be included in the facility technical specifications

iv. Classified as engineered safety features or used to support or ensure the operations of engineered safety features within design limits

v. Assumed to function, or for which credit is taken, in the accident analysis for the facility, as described in the DCD or FSAR (as applicable)

vi. Used to process, store, control, measure, or limit the release of radioactive materials

vii. Used in a special low-power testing program to be conducted at power levels no greater than 5 percent for the purpose of providing meaningful technical information beyond that obtained in the normal startup test program, as required for the resolution of TMI Action Item I.G.1

viii. Identified as risk- significant in the design-specific probabilistic risk assessment

B. The abstracts should include test objectives, prerequisites, test methods, significant parameters and plant performance characteristics to be monitored, and acceptance criteria in sufficient detail to establish the functional adequacy of the SSCs and design features tested.

C. For new, unique, or FOAK design features used in the facility, the functional testing requirements and acceptance criteria necessary to verify their performance should be submitted for review and approval.

D. If the testing method will not subject the SSC to representative design operating conditions, the test abstract should contain sufficient information to justify the proposed test method.

6. Initial Test Program (ITP) Acceptance Criteria

DC Applicants

A. The applicant should provide in Tier 1 a general description of the preoperational and power ascension test programs and the major program documents that define how the ITP will be conducted and controlled (i.e., a site-specific startup administrative manual, test specifications, and test procedures). Tier 2, Chapter 14.2, should contain a complete description of the ITP.

B. The applicant should describe the key elements of the ITP in Tier 1 to ensure that the COL applicant cannot unilaterally initiate subsequent changes in the conduct of the ITP.

C. The applicant should include provisions to ensure that test procedures and test specifications are made available to the NRC.

COL Applicants

A. Applicants referencing a certified design should provide a clearly and sufficiently described ITP in terms of scope and level of detail in accordance with the rule certifying the design and the design control document.

B. An applicant which does not reference a certified design should provide a clearly and sufficiently described ITP in terms of scope and level of detail in accordance with RG 1.68.

C. The COL applicant will provides plans for preoperational testing and initial operations to meet the requirements in 10 CFR 52.79(a)(28). For consistency between the ITP and ITAAC regulations, the NRC staff also reviews preoperational test acceptance criteria under the ITP to verify that they are consistent with acceptance criteria under the preoperational test ITAAC.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this DSRS section is discussed in the following paragraphs:

1. 10 CFR 50.2, *Prototype plant* means a nuclear reactor that is used to test design features, such as the testing required under 10 CFR 50.43(e). The prototype plant is similar to FOAK or standard plant design in all features and size, but may include additional safety features to protect the public and the plant staff from the possible consequences of accidents during the testing period.

2. For DC reviews, even though there is no requirement for a DC applicant to provide an ITP, the staff should review the test abstracts provided by the DC applicant for completeness and suitability for development of an ITP by a COL applicant under 10 CFR 52.79(a)(28). For consistency between the ITP and ITAAC regulations, the NRC staff also reviews the preoperational test acceptance criteria under the ITP to verify that they are consistent with the acceptance criteria under preoperational test ITAAC.

3. 10 CFR 52.47(a)(2)(iii) requires a DC applicant to provide design and test acceptance criteria for unique, unusual or enhances safety features having a significant bearing for accidental release of radioactive material. 10 CFR 52.79(a)(2)(iii) requires, in part, that the COL FSAR incorporates unique, unusual or enhanced safety features.10 CFR 52.47(a)(2)(iii) requires that a DC application must provide design and test acceptance criteria for unique, unusual or enhanced safety features having a significant bearing for accidental release of radioactive material. The COL application includes unique, unusual or enhanced safety feature systems from the DC that are incorporated by reference into the FSAR.

4. The DC and COL applicant should also provide plans for preoperational testing and initial operations. This includes unique, unusual, FOAK design features or enhanced safety features. This also applies to a DC or COL applicant referencing a DC under 10 CFR Part 52. The DC applicant would provide design and test acceptance critera on plans for preoperational, initial criticality, low power and power ascension tests, including unique, unusual, FOAK design features or enhanced safety features having a significant bearing for accidental release of radioactive material. The COL applicant would provide plans for site specific tests. The COL would also implement the ITP to confirm that all design features, including FOAK design features, meet their design and test acceptance criteria.

5. 10 CFR 50.43(e) provides that applications for a DC COL, or ML that propose nuclear reactor designs which differ significantly from light-water reactor designs that were licensed before 1997, or use simplified, inherent, passive, or other innovative means to accomplish their safety functions, will be approved only if:

   (1)(i) The performance of each safety feature of the design has been demonstrated through either analysis, appropriate test programs, experience, or a combination thereof;

   (ii) Interdependent effects among the safety features of the design are acceptable, as demonstrated by analysis, appropriate test programs, experience, or a combination thereof; and

   (iii) Sufficient data exist on the safety features of the design to assess the analytical tools used for safety analyses over a sufficient range of normal operating conditions, transient conditions, and specified accident sequences, including equilibrium core conditions; or

   (2) There has been acceptable testing of a prototype plant over a sufficient range of normal operating conditions, transient conditions, and specified accident sequences, including equilibrium core conditions. If a prototype plant is used to comply with the testing requirements, then the NRC may impose additional requirements on siting, safety features, or operational conditions for the prototype plant to protect the public and the plant staff from the possible consequences of accidents during the testing period.

6. 10 CFR 52.47(c)(2) require, in part, that an application for certification of a nuclear power reactor design that differs significantly from the light-water reactor designs described in paragraph (c)(1) of this section or uses simplified, inherent, passive, or other innovative means to accomplish its safety functions must provide an essentially complete nuclear power reactor design except for site-specific elements such as the service water intake structure and the ultimate heat sink, and must meet the requirements of 10 CFR 50.43(e).

7. 10 CFR 52.47(c)(3) requires that an application for certification of a modular nuclear power reactor design must describe and analyze the possible operating configurations of the reactor modules with common systems, interface requirements, and system interactions. The final safety analysis must also account for differences among the configurations, including any restrictions that will be necessary during the construction and startup of a given module to ensure the safe operation of any module already operating.

8. 10 CFR 52.79(a)(24) requires, in part, that if the COL application use simplified, inherent, passive or other innovative means to accomplish their safety function, the application must describe how the design meets the requirements in 10 CFR 50.43(e). 10 CFR 52.79(a)(28) requires the COL application include plans for preoperational testing and initial operations of the new reactor. This includes plans for testing unique, unusual, simplified, inherent, passive, or other innovative FOAK design features having a significant bearing for accident release of radioactive material or testing of a prototype plant. Thus, the regulations in 10 CFR 50.43(e) also apply to DC and COL applications licensed under 10 CFR 52.47(c)(2) and 10 CFR 52.79(a)(24).

9. 10 CFR 52.79(a)(28) requires the COL application to include plans for preoperational testing and initial operations of the new reactor. This includes plans for testing unique, unusual or FOAK design features having a significant bearing for accident release of radioactive material. The DC applicant would provide design and test acceptance criteria for their portion of the design while the COL applicant would provide design and test acceptance criteria for their site-specific porion of the plant design (e.g. ultimate heat sink). The COL would then implement the ITP to confirm that design features meet design and test acceptance criteria for the referenced DC and site-specific design features of the plant. For consistency between the ITP and ITAAC regulations, the NRC staff also reviews preoperational tests acceptance criteria under the ITP to verify that they are consistent with the acceptance criteria under preoperational test ITAAC.

10. As noted in the NRC statements of consideration (SOC) for "Licenses, Certifications and Approvals for Nuclear Power Plants – Final Rule," Federal Register Notice (FRN) Volume 72, No. 166, (August 28, 2007), pages 49369 and 49370, states, in part, the requirements, noted above, demonstrate the performance of new safety features for nuclear power plants (advanced reactors) that differ significantly from evolutionary light water reactors or that use simplified, inherent, passive or other innovative means to accomplish their safety functions. The requirements, noted above, were included in 10 CFR 52 to ensure that these new safety features will perform as predicted in the applicant's FSAR, to provide sufficient data to validate analytical codes, and that the effects of systems interactions are acceptable.

    The design qualification testing requirements may be met with either separate affects or integral system tests, prototype tests, or a combination of tests, analysis, and operating experience. These requirements implement the Commission's policy of proof-of-performance testing for all advanced reactors and its goal is to resolve all safety issues before authorizing construction.

    Some prototype plant tests or FOAK tests may not be resolved until after fuel load and plant startup. Based on the NRC staff's review information submitted in DC applications, FOAK tests may not be needed on subsequent COL plants, if the COL can demonstrate through data collection and operating experience that these design features meet their design and test acceptance criteria. The test plans should include test acceptance criteria that provide objective evidence that completion of all tests under the ITP, including unque, unusual, and FOAK tests will meet their design basis. For additional details on FOAK tests and design qualification tests, see RG 1.68, Revision 4, Appendix A, Sections 6 and 7.

11. 10 CFR 30.53(c), as it relates to this DSRS section, requires that each licensee (defined as an entity licensed to receive and possess byproduct material in this context) perform, or permit the Commission to perform, tests of radiation detection and monitoring

instruments. In nuclear power plants, radiation detection and monitoring instruments are used for ambient monitoring related to worker radiation protection, effluent monitoring, automatic initiation of features to mitigate accidental releases of radioactive materials, and automatic initiation of engineered safety features to minimize the consequences of design-basis accidents. Application of 10 CFR 30.53(c) to the ITP ensures that the capabilities to perform these functions are adequately verified initially and that deficiencies are identified and corrected. This provides increased assurance of reliable radiation detection/monitoring and instrument response to any detected adverse radiological conditions.

12. Section XI of Appendix B to 10 CFR 50 requires that a test program be established to ensure that all testing required to demonstrate that SSCs will perform satisfactorily in service is identified and performed in accordance with written test procedures that incorporate the requirements and acceptance limits in applicable design documents. The test program should include, as appropriate, proof tests before the installation, preoperational tests, and operational tests during plant operation of SSCs. Test procedures should include provisions for ensuring that all prerequisites for the given test have been met, adequate test instrumentation is available and used, and the test is performed under suitable environmental conditions. Test results should be documented and evaluated to ensure that test requirements have been satisfied.

    The SSCs that are subject to initial testing perform safety functions, including fission product containment and/or control, reactivity monitoring and control, reactor safe shutdown (including maintaining the safe shutdown), core cooling, accident prevention, and consequence mitigation, as specified in the design and as assumed/credited in safety analyses. The application of Section XI of Appendix B to 10 CFR Part 50 to the ITP ensures that DC, COL, and OL applicants provide all testing required to demonstrate that (1) SSC capabilities to perform specified/analyzed functions are initially verified with adequate precision and accuracy, (2) necessary SSC and plant baseline performance data are obtained, (3) deficiencies are identified and corrected, and (4) activities are conducted in a sequence and manner that minimizes operational reliance on untested SSCs/safety functions. This provides a high degree of assurance of SSC and overall plant readiness for safe operation within the bounds of the design and safety analyses, protection against unexpected or unanalyzed SSC/plant behavior, and prevention of early SSC/safety function failures in service.

13. Appendix J to 10 CFR Part 50 requires, in part, that upon completion of construction of the primary reactor containment, including installation of all portions of mechanical, fluid, electrical, and instrumentation systems penetrating the primary reactor containment pressure boundary, and prior to any reactor operating period, preoperational leakage rate tests are conducted as specified (e.g., in Section III.A). The primary reactor containment provides a barrier against the release of fission products after accidents. The extent of overall containment leakage at pressures associated with accident conditions affects the public dose and environmental damage consequences of accidents. Application of Appendix J to the ITP ensures that the containment performs as a leakage barrier as specified in the design and as assumed/credited in safety analyses that evaluate the public dose and environmental consequences of design-basis accidents.

14. 10 CFR 52.79 requires that each COL application contain a final SAR (FSAR) that describes the facility, presents the design bases and the limits on its operation, and presents a safety analysis of the SSCs and of the facility as a whole, including plans for

preoperational testing and initial operations. A major ITP objective (including preoperational testing and testing during initial operation) is to verify that SSCs are capable of performing their safety functions as specified in the design and as assumed/credited in safety analyses. Application of 10 CFR 52.79 to the ITP ensures that the applicant submits adequate information, commitments, and plans to demonstrate that the capability will exist for initial operation within the bounds of the design and safety analyses and that initial testing activities will be conducted in a sequence and manner that minimizes operational reliance on untested SSCs/safety functions.

III. REVIEW PROCEDURES

These review procedures are based on the identified DSRS acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

1. Selected Programs and Guidance - In accordance with the guidance in NUREG-0800, "Introduction - Part 2: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: Integral Pressurized Water Reactor Edition" (NUREG-0800 Intro Part 2) as applied to this DSRS Section, the staff will review the information proposed by the applicant to evaluate whether it meets the acceptance criteria described in Subsection II of this DSRS. As noted in NUREG-0800 Intro Part 2, the NRC requirements that must be met by an SSC do not change under the SMR framework. Using the graded approach described in NUREG-0800 Intro Part 2, the NRC staff may determine that, for certain structures, systems, and components (SSCs), the applicant's basis for compliance with other selected NRC requirements may help demonstrate satisfaction of the applicable acceptance criteria for that SSC in lieu of detailed independent analyses. The design-basis capabilities of specific SSCs would be verified where applicable as part of completion of the applicable ITAAC. The use of the selected programs to augment or replace traditional review procedures is described in Figure 1 of NUREG-0800, Introduction - Part 2. Examples of such programs that may be relevant to the graded approach for these SSCs include:

    - 10 CFR Part 50, Appendix A, General Design Criteria (GDC), Overall Requirements, Criteria 1 through 5
    - 10 CFR Part 50, Appendix B, Quality Assurance (QA) Program
    - 10 CFR 50.49, Environmental Qualification of Electrical Equipment (EQ) Program
    - 10 CFR 50.55a, Code Design, Inservice Inspection and Inservice Testing (ISI/IST) Programs
    - 10 CFR 50.65, Maintenance Rule requirements
    - Reliability Assurance Program (RAP)
    - 10 CFR 50.36, Technical Specifications
    - Availability Controls for SSCs Subject to Regulatory Treatment of Non-Safety Systems (RTNSS)
    - Initial Test Program (ITP)
    - Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)

This list of examples is not intended to be all-inclusive. It is the responsibility of the technical reviewers to determine whether the information in the application, including the degree to which the applicant seeks to rely on such selected programs and guidance, demonstrates that all acceptance criteria have been met to support the safety finding for a particular SSC.

2. In accordance with 10 CFR 52.47(a)(8), (21), and (22), and 10 CFR 52.79(a)(17), (20) and (37), for design certification or combined license applications submitted under Part 52, the applicant is required to (1) address the proposed technical resolution of unresolved safety issues and medium- and high-priority generic safety issues which are identified in the version of NUREG-0933 current on the date up to 6 months before the docket date of the application and which are technically relevant to the design; (2) demonstrate how the operating experience insights have been incorporated into the plant design; and, (3) provide information necessary to demonstrate compliance with any technically relevant portions of the Three Mile Island requirements set forth in 10 CFR 50.34(f), except paragraphs (f)(1)(xii), (f)(2)(ix), and (f)(3)(v) for a DC application, and except paragraphs (f)(1)(xii), (f)(2)(ix), (f)(2)(xxv), and (f)(3)(v) for a COL application. These cross-cutting review areas should be addressed by the reviewer for each technical subsection and relevant conclusions documented in the corresponding safety evaluation report (SER) section.

The designated reviewer will review ITPs submitted by DC or COL applicants, comparing them to the criteria described in Subsection II. When necessary, the reviewer will prepare one or more requests for additional information for the applicant or holder and will review the responses for acceptability.

The reviewer is responsible for the review and evaluation of all subsequent amendments to the FSAR until the ITP is completed to ensure that any changes in design or commitments that affect the ITP will continue to satisfy the acceptance criteria described in Subsection II.

For review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the FSAR meets the acceptance criteria. DCs have referred to the FSAR as the design control document (DCD). The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

In general, for review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit or other NRC approvals (e.g., manufacturing license, site suitability report or topical report). However, the scope of this DSRS section only addresses the NuScale DC application and COL applications that reference the NuScale SMR certified design."

The reviewer's determination of the adequacy of the ITP commitments, description of methods for meeting the commitments, organizational arrangements, and capabilities to fulfill the test program should lead to the conclusion of acceptability, as described in Subsection IV.

IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the staff's technical review and analysis, as augmented by the ITP in accordance with the staff's technical review approach in the DSRS Introduction, support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

The staff concluded that the initial plant test program meets the following requirements:

1. Section XI of Appendix B to 10 CFR Part 50, which requires the establishment of a test program to ensure that all testing required to demonstrate that SSCs will perform satisfactorily in service and that the test program is conducted in accordance with written test procedures that incorporate the requirements and acceptance limits in applicable design documents.

2. Section III.A.4 of Appendix J to 10 CFR Part 50, which requires a preoperational measurement of the overall integrated leak-tightness of the primary reactor containment under specified pressure conditions.

3. 10 CFR 52.79(a)(28), which requires COL applicants to provide plans for preoperational testing and initial operations (where applicable). The staff has reviewed the information provided in the FSAR on the applicant's test program in accordance with DSRS Section 14.2. This review included an evaluation of the applicant's administrative measures to control (1) the conduct of the ITP, (2) the schedule for conducting the test program, (3) the sequence of startup testing to be performed, (4) the methods for conducting individual tests and the acceptance criteria to be used in evaluating the test results for plant SSCs, (5) the test programs' conformance with applicable regulations, (6) responsibilities, authorities, and qualifications, and (7) the conformance with RGs applicable to the ITP. The review also included an evaluation of the results of the applicant's review of operating and testing experiences at other reactor facilities and their effect on the ITP, and the incorporation and trial use of plant operating and emergency procedures during the test program. The staff has concluded that the information provided in the application meets the acceptance criteria in this DSRS and describes an acceptable ITP that, when successfully completed, will demonstrate the functional adequacy of plant SSCs.

   For DC and COL reviews, the findings will also summarize the staff's evaluation of requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this DSRS section.

V. IMPLEMENTATION

The regulations in 10 CFR 52.17(a)(1)(xii), 10 CFR 52.47(a)(9), and 10 CFR 52.79(a)(41) establish requirements for applications for ESPs, DCs, and COLs, respectively. These regulations require the application to include an evaluation of the site (ESP), standard plant design (DC), or facility (COL) against the Standard Review Plan (SRP) revision in effect six months before the docket date of the application. While the SRP provides generic guidance, the staff developed the SRP guidance based on the staff's experience in reviewing applications for construction permits and operating licenses for large light-water nuclear power reactors. The proposed small modular reactor (SMR) designs, however, differ significantly from large light-

water nuclear reactor power plant designs.

In view of the differences between the designs of SMRs and the designs of large light-water power reactors, the Commission issued SRM- COMGBJ-10-0004/COMGEA-10-0001, "Use of Risk Insights to Enhance the Safety Focus of Small Modular Reactor Reviews," dated August 31, 2010 (ML102510405) (SRM). In the SRM, the Commission directed the staff to develop risk-informed licensing review plans for each of the SMR design reviews, including plans for the associated pre-application activities. Accordingly, the staff has developed the content of the DSRS as an alternative method for the evaluation of a NuScale-specific application submitted pursuant to 10 CFR Part 52, and the staff has determined that each application may address the DSRS in lieu of addressing the SRP, with specified exceptions. These exceptions include particular review areas in which the DSRS directs reviewers to consult the SRP and others in which the SRP is used for the review. If an applicant chooses to address the DSRS, the application should identify and describe all differences between the design features (DC and COL applications only), analytical techniques, and procedural measures proposed in an application and the guidance of the applicable DSRS section (or SRP section as specified in the DSRS), and discuss how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria.

The staff has accepted the content of the DSRS as an alternative method for evaluating whether an application complies with NRC regulations for NuScale SMR applications, provided that the application does not deviate significantly from the design and siting assumptions made by the NRC staff while preparing the DSRS. If the design or siting assumptions in a NuScale application deviate significantly from the design and siting assumptions the staff used in preparing the DSRS, the staff will use the more general guidance in the SRP as specified in 10 CFR 52.17(a)(1)(xii), 10 CFR 52.47(a)(9), or 10 CFR 52.79(a)(41), depending on the type of application. Alternatively, the staff may supplement the DSRS section by adding appropriate criteria in order to address new design or siting assumptions.

VI. REFERENCES

1. 10 CFR Part 20, "Standards for Protection Against Radiation."

2. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

3. 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants."

4. GDC 61, "Fuel Storage and Handling and Radioactivity Control."

5. GDC 19, "Control Room."

6. GDC 4, "Environmental and Dynamic Effects Design Bases."

7. RG 1.7, "Control of Combustible Gas Concentrations in Containment Following a Loss-of-Coolant Accident."

8. RG 1.112, "Calculations of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors."

9. RG 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors.”

10. ANSI/ANS Standard 18.1-1999, “Source Term Specification,” American National Standards Institute/American Nuclear Society.”

11. NUREG-0737, “Clarification of TMI Action Plan Requirements.”

12. 40 CFR Part 190, “Environmental Radiation Protection Standards For Nuclear Power Operations.”

13. RG 1.89, “Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants.”

14. RG 1.143, “Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants.”

15. RG 1.26, “Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants.”

16. RG 1.29, “Seismic Design Classification.”

17. RG 1.117, “Tornado Design Classification.”

18. RG 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition).”

19. EPRI, “Pressurized Water Reactor Primary Water Chemistry Guidelines.”

20. EPRI, “Pressurized Water Reactor Primary Water Zinc Application Guidelines.”

21. EPRI, “Advanced Light Water Reactor Utility Requirements Document, Volume III, ALWR Passive Plant.”

22. NUREG-1242, “NRC Review of Electric Power Research Institute's Advanced Light Water Reactor Utility Requirements Document, Passive Plant Designs” Volume 3, Part 1 and Volume 3, Part 2 (ADAMS Accession Nos. ML070600372 and ML070600373).

23. EPRI, “Cobalt Reduction Guidelines.”

RG 8.8, “Information Relevant to Assuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as is Reasonably Achievable.”